SMART INDIA HACKATHON 2025

- **Problem Statement ID – SIH25054**
- **Problem Statement Title- “Automated High Current Short Circuit Test System for MCB to comply with IEC 60898-1:2015”**
- **PS Category- Hardware**
- **Team Name – Team ElectroniX**

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Automated Transformer-Based High-Current Test Station

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❖ Proposed Solution

1. **Generates up to 10,000A short-circuit current** using a custom transformer
2. **Automatically configures test circuit** with switchable resistors & inductors (R & XL)
3. **Safely mounts and tests MCBs** (SP, DP, TP, FP) inside an arc-proof chamber
4. **Runs tests automatically** through PLC/Industrial PC control
5. **Captures high-speed waveforms** (current, voltage, trip time) for analysis
6. **Provides user-friendly interface** for test setup and automated report generation
7. **Built-in safety systems** (emergency stop, interlocks, cooling, blast shield)

Relevance to Problem Statement

1. Automates high-current short-circuit testing of MCBs as required by IEC 60898-1:2015.
2. Ensures safe, accurate, and repeatable certification tests, reducing human risk and errors.

Uniqueness of Solution

1. Integrated system combining high-current source, automated R/XL banks, and real-time waveform analysis.
2. End-to-end automation from test setup to report generation, unlike existing manual/semi-automated methods.

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TECHNICAL APPROACH

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Tools, Hardware & Technology Used

- High-Current Transformer
- Automated R & XL Switching Banks
- PLC / Industrial PC
- High-Speed DAQ System
- HMI (Touchscreen Interface)
- Rogowski Coil & Voltage Dividers
- Universal MCB Test Fixture
- Arc-Proof Enclosure with Interlocks
- Emergency Stop & Safety Sensors

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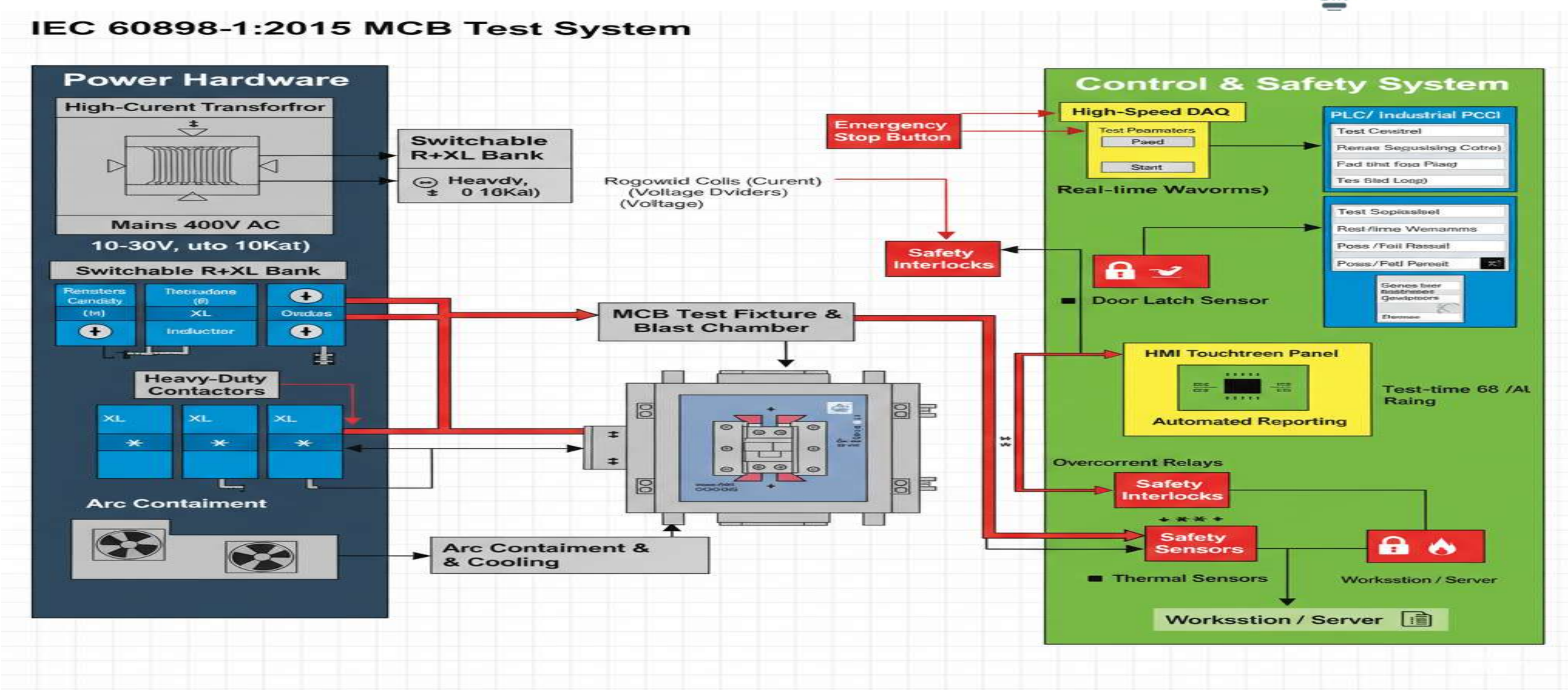
FLOW DIAGRAM



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FEASIBILITY AND VIABILITY

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- **Feasibility Analysis**

1. Technically feasible using proven transformer-based high-current test methods
2. Automation (PLC + DAQ + HMI) aligns with existing industrial control technology
3. Scalable design allows prototyping at lower current before full 10 kA implementation

- **Potential Challenges & Risks**

1. High cost of custom transformer and power components
2. Safety hazards due to extreme short-circuit currents and arc energy
3. Complexity of integrating control, DAQ, and protection systems
4. Compliance with IEC 60898-1:2015 standards requires precision and validation

- **Strategies to Overcome Challenges**

1. Start with **scaled-down prototype** for validation before full-scale build
2. Implement **robust safety systems**: interlocks, blast-proof chamber, emergency shutoff
3. Use **digital twin simulation** to test control logic before live hardware testing
4. Partner with **certified labs and industry experts** for compliance and validation

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IMPACT AND BENEFITS

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- **Potential Impact on Target Audience**

1. Manufacturers → Faster and safer MCB certification process
2. Testing Labs → Improved accuracy, repeatability, and compliance with standards
3. Consumers → Access to safer electrical products with reliable protection
4. Regulators → Easier enforcement of IEC standards with transparent reports

- **Benefits of the Solution**

1. Social → Enhanced electrical safety, reduced risk of accidents and fires
2. Economic → Lower testing costs, faster certification, improved market competitiveness
3. Environmental → Optimized testing reduces energy waste and equipment damage
4. Technological → Pushes innovation in automation, safety systems, and smart testing

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RESEARCH AND REFERENCES

Title / Source	Key Ideas & How They Relate
High-Performance Breaking and Intelligent of Miniature Circuit Breakers (MDPI)	Experiments with a prototype that passed a short-circuit breaking test (1000 V / 10 kA); includes digital monitoring and remote control features for MCBs. Useful for "breaking" part and also for thinking of instrumentation + control. (MDPI)
Performance of the High-Current Transformer across harmonic frequencies (Energies journal)	Looks at how a high-current transformer behaves when subjected to different frequencies and harmonic content. Helps in understanding transformer design, distortion, safety limits. (MDPI)
Improved Testing Method Using the Multi-Transformers Synthetic Circuit to Verify Capacitive Charging Current Switching Capability	Though more for high-voltage circuit breakers and capacitor switching, this shows techniques for synthetic circuits (switching, combined transformer + capacitor banks) which are similar to R/XL bank ideas. (MDPI)